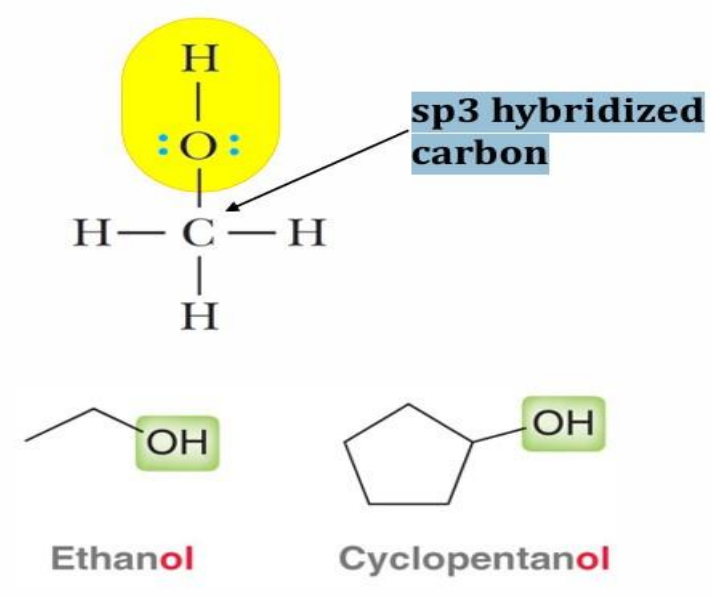
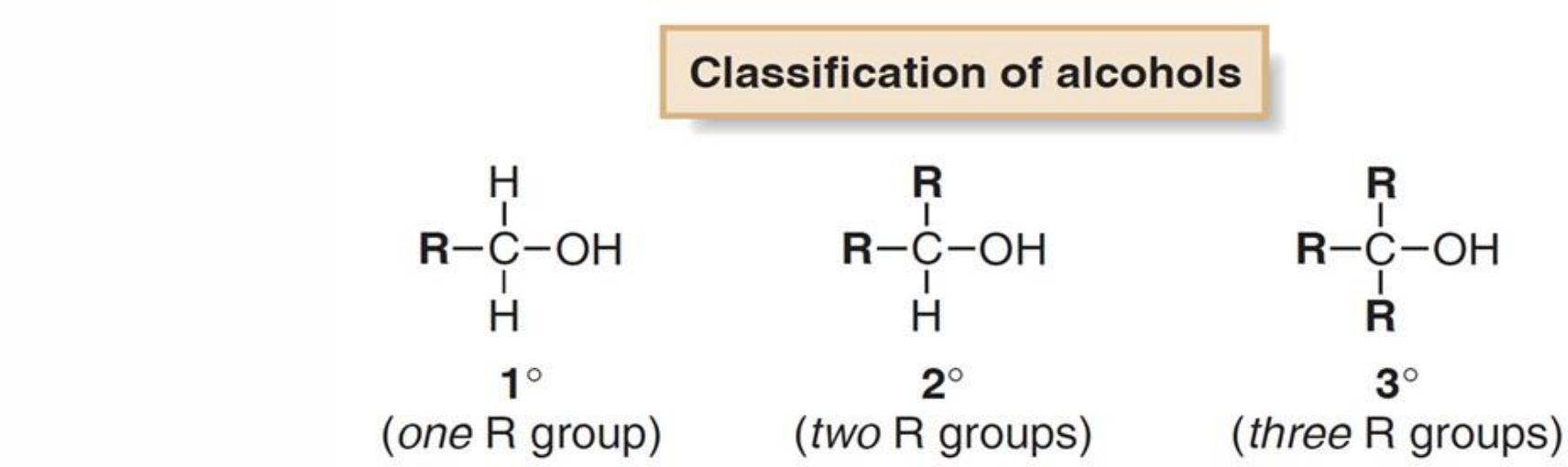
Alcohols are compounds that possess a hydroxyl group (OH) connected to an sp^3 hybridized carbon atom, and are characterized by names ending in "OL":



Alcohols are important because they can be converted sp3 hybridized carbon into many other types of compounds, including alkenes, haloalkanes, aldehydes, ketones, carboxylic acids, and esters. Not only can alcohols be converted to these compounds, but these compounds can also be converted to alcohols. Thus, alcohols play a central role in the interconversion of organic functional groups

CLASSIFICATION OF ALCOHOLS

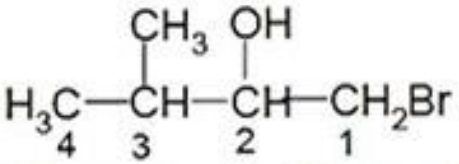
Alcohols are classified as primary (1°), secondary (2°), or tertiary (3°) based on the number of carbon atoms bonded to the carbon with the OH group.



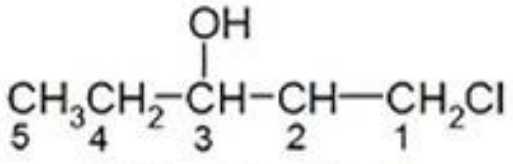
Primary alcohols (methanol, ethanol, propanol, butanol, etc.) exhibit antibacterial properties.

Nomenclature of alcohols

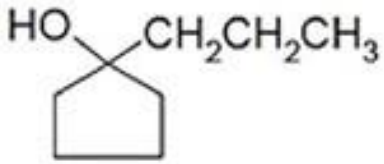
Generally, the name of an alcohol ends with-ol. An alcohol can be named as an alkyl alcohol, usually for small alkyl groups e.g. methyl alcohol and ethyl alcohol. The longest carbon chain bearing the __OH group is used as the parent; the last-e from this alkane is replaced by an-ol to obtain the root name. The longest chain is numbered starting from the end nearest to the __ OH group, and the position of the __OH group is numbered. Cyclic alcohols have the prefix cyclo-, and the __OH group is deemed to be on C-1.



1-Bromo-3-methyl-2-butanol
(The -OH is at C-2 of butane)

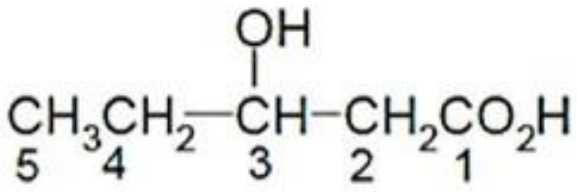


1-Chloro-3-pentanol
(The -OH is at C-3 of pentane)

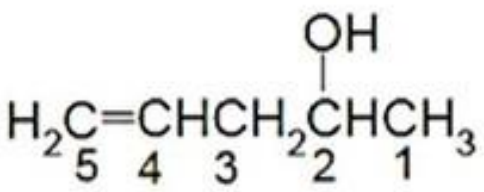


1-Propylcyclopentanol

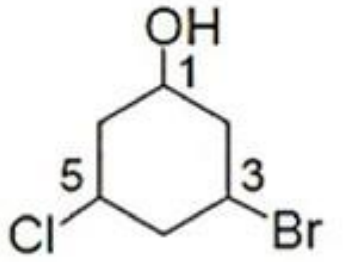
Alcohols with double or triple bonds are named using the-ol suffix on the alkene or alkyne name. Numbering gives the hydroxyl group the lowest possible number. When numbers are also given for the multiple bond position, the position of the hydroxyl can be written immediately before the-ol prefix. If the hydroxyl group is only a minor part of the structure, it may be named as a hydroxy-substituent



3-Hydroxypentanoic acid

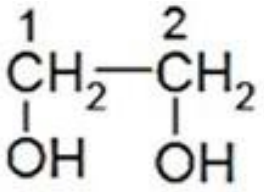


Pent-4-en-2-ol

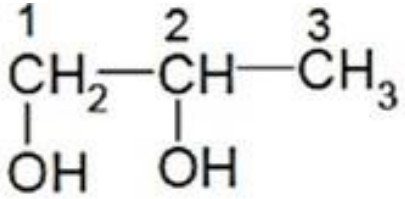


3-Bromo-5-chlorocyclohexanol

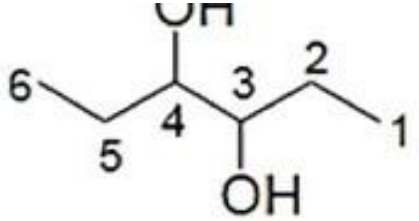
Diols are compounds with two hydroxyl groups. They are named as for alcohols except that the suffix-diol is used and two numbers are required to locate the hydroxyls. 1,2-diols are called glycols. The common names for glycols usually arise from the name of the alkene from which they are prepared.



1,2-Ethane diol
(Ethylene glycol)



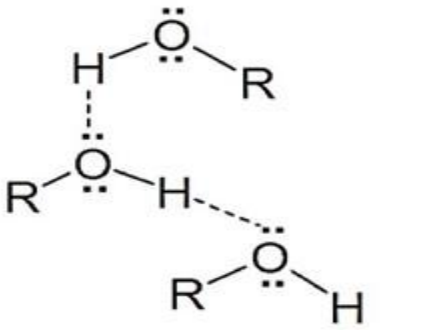
1,2-propane diol
(Propylene glycol)



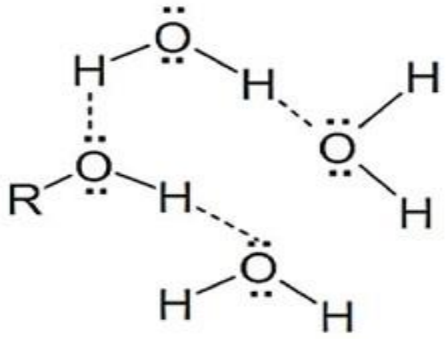
3,4-Hexanediol

Physical properties of alcohols

Alcohols can be considered as organic analogues of water. Both the C__O and O__H bonds are polarized due to the electronegativity of the oxygen atom. The highly polar nature of the O__H bond results in the formation of hydrogen bonds with other alcohol molecules or other hydrogen bonding systems, e.g. water and amines. Thus, alcohols have considerably higher boiling point due to the hydrogen bonding between molecules (intermolecular hydrogen bonding). They are more polar than hydrocarbons, and are better solvents for polar molecules.



Hydrogen bonds between alcohol molecules



Hydrogen bonds to water in aqueous solution

Preparation of alcohols

1. Hydration of Alkenes

$$H_2O + H^+ \rightarrow H_3O^+$$

$$> C = C < \ + H_2O \leftrightarrow > CH - C - OH <$$

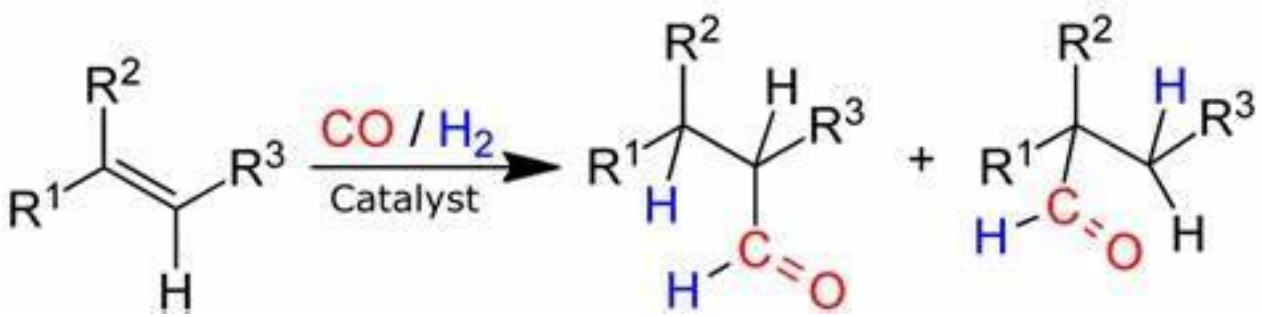
$$CH_3CH = CH_2 + H_2O \leftrightarrow CH_3CH - OHCH_3$$

2. Hydroboration of Alkenes

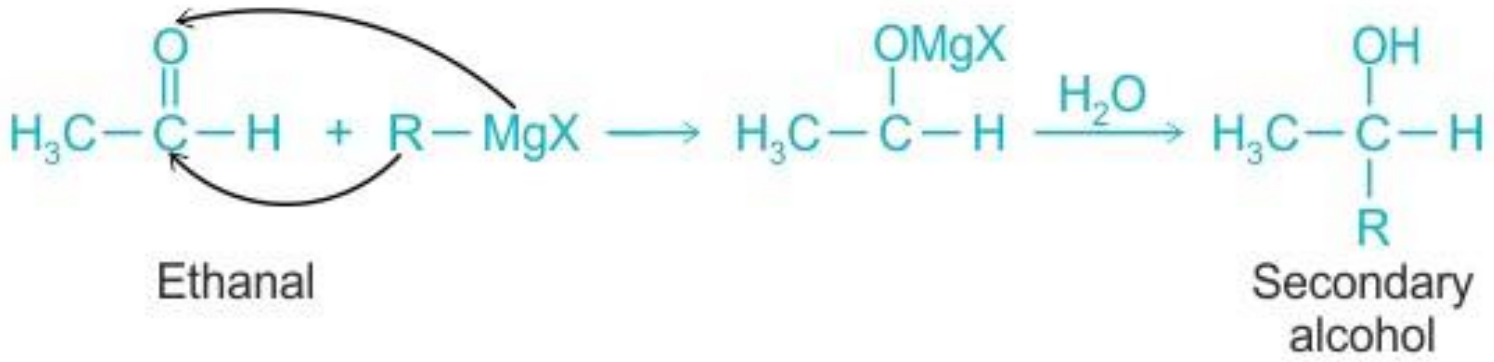
$$CH_3CH = CH_2 + (H - BH_2)_2 \rightarrow CH_3CH_2CH_2BH_2 \longrightarrow (CH_3CH_2CH_2)_2BH$$

$$(CH_3CH_2CH_2)_2BH \rightarrow (CH_3CH_2CH_2)_3B \longrightarrow 3CH_3 - CH_2 - CH_2 - OH + B(OH)_3$$

3. Hydroformylation of Alkenes

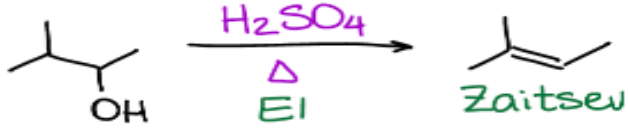


4. Grignard Synthesis



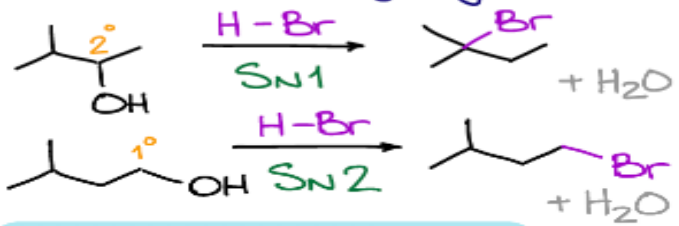
REACTIONS of ALCOHOLS

Acid-Catalyzed Dehydration

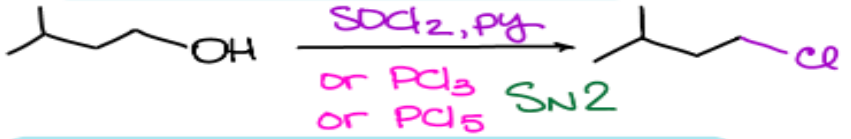


E2 Dehydration with $POCl_3$

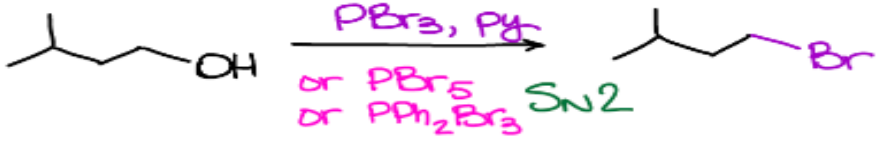
Reaction with Hydrogen Halides



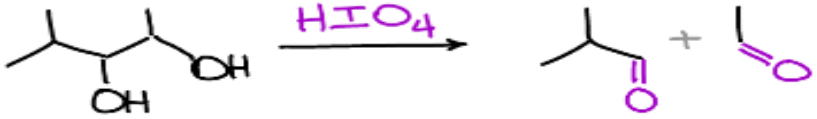
Conversion to Chlorides with $SOCl_2$; PCl_3 ; or PCl_5



Conversion to Bromides with PBr_3 ; PBr_5 ; or PPh_2Br_3



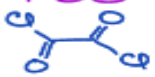
Oxidative Cleavage of Vicinal Diols with HIO_4

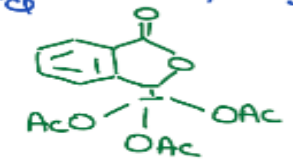


Oxidation of Alcohols

{ Jones Oxidation (CrO_3 , H_2SO_4 or H_2CrO_4 ; or $K_2Cr_2O_7$, H_2SO_4)

{ PCC or PDC

Swern:  , DMSO, Et_3N

Dess-Martin: 

Secondary alcohols $\xrightarrow{[O]}$ ketones

Any oxidation method including hypochlorite or TEMPO oxidation